CHAPTER 6: WATER-QUANTITY CONSIDERATIONS

Thus far, the primary focus of this guidebook has been on the water quality aspects of stormwater management. Before the actual design is discussed several design considerations should be investigated.

DESIGN STORM

Before a detention or retention facility can be designed, it is necessary to determine what type of protection is desired. More communities around the United States are beginning to use the 100-year, 24-hour storm as the design standard. Such a standard is consistent with the National Flood Insurance Program and current floodplain mapping for the State of Michigan.

A primary goal of stormwater management is to maintain flood discharges at current levels, even after development has taken place. Without adequate stormwater management, flood discharges, flood damages, and erosion may take place at downstream locations, as a drainage basin changes from undeveloped to developed.

Before selecting a design storm, it is advisable to look at downstream properties to see what is or may be impacted by flooding. If flood damages are occurring frequently, it will not be enough to look at only one design storm, such as the 100 -year flood. It will be necessary to look at a range of storms to be sure that the proposal is not increasing flooding potential for downstream properties. There may be instances in which a detention pond that reduces or maintains the existing 100 -year discharge may increase the impact of flooding caused by the more frequent floods.

Table 6.1 is an example of frequency and rainfall amounts. Appendix B shows the plots of the remainder of the state.

Table 6.1 - Frequency and Rainfall Amounts for Eaton County

Frequency	1-yr	2-yr	5-yr	10-yr	50-yr	100-yr
24-hr. rainfall (inches)	2.2	2.6	3.1	3.5	4.6	5.1

LOCATION OF DETENTION STORAGE

In the past, communities have passed ordinances that require peak runoff rates after development to be less than or equal to runoff rates before development. The criteria may change from community to community; however, the goal is to maintain the current runoff rates through the use of on -site storage. While the concept may be honorable, in many instances, the result of the ordinance is the construction of a number of detention basins throughout the community for which the combined effects actually increase downstream flooding.

The size and location of detention storage impacts the peak flood flows (reference 20). Basin wide planning is essential to result in properly sized basins and to prevent flood discharges from being increased.

In 1986, the DEQ studied the Sargent Creek watershed in Oakland County to determine the impact that detention has had on the flood flows of this urbanized basin (reference 29). As the watershed was urbanizing, on -site stormwater detention was required. The study looked at the impact that the on -site detention basins had on the flood flows as compared to a regional detention basin or a series of detention basins. It was found that an in -line detention basin would need about one-half of the amount of land that th e on-site detention basins needed to accomplish the same impact on flood discharges. The study also indicates that in some instances regulated on -site detention ponds have increased peak flows downstream by delaying outlet peaks to the extent that all of the flood peaks combine simultaneously.

At the extreme upper and lower ends of the watershed, detention ponds will have little beneficial impact on peak flows. Since the runoff from the extreme upper end of the watershed will reach the downstream areas after the flood peaks have already occurred, detention in the upper watershed area would virtually have no impact on peak flows. At the extreme lower end, detention would delay runoff that normally would have been gone and release it when the peak flow from upstream reaches the site. This would result in an increased flood peak. Figure 6.1 illustrates the most effective locations for detention ponds. It should be noted that this figure applies only for water- **quantity** purposes. Treatment for water **quality** should be addressed **throughout** the watershed.

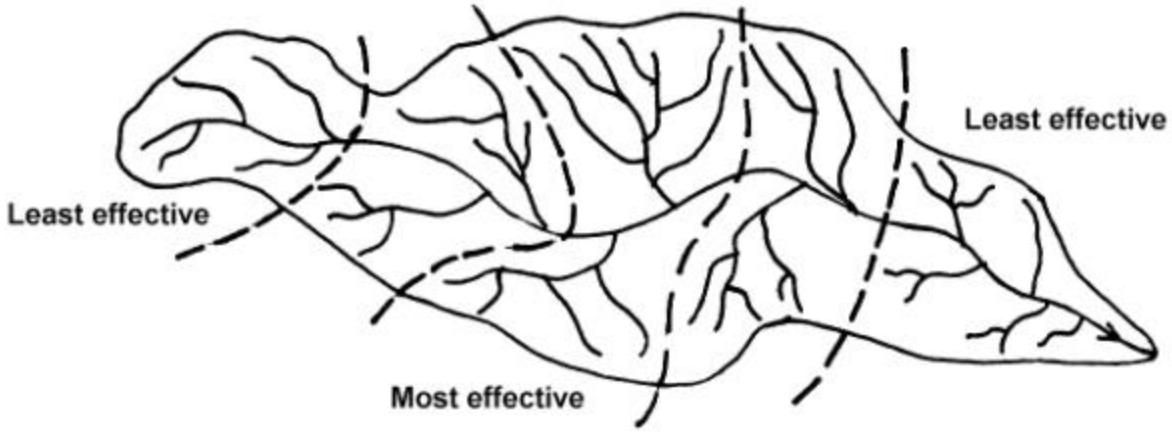

Figure 6.1 - Effectiveness of Detention Location within a Watershed

The installation of detention facilities at the lower end of a subwatershed may hold water that would have normally been gone. The release of the water may occur at the same time that the flood peak on the main channel reaches the site. As a result, the detention basin at such a location may actually increase the flood peak. For this reason, it is essential that the entire watershed be considered when the stormwater management plan is being developed. An effective detention pond design must look at the timing of the flood hydrographs, in addition to the volume of runoff.

ON-SITE DETENTION

There is quite a bit of information available for the design of individual detention ponds, which primarily deal with volume of runoff and rate of runoff. However, there is not much information on the impacts of on -site detention ponds as opposed to a regional detention

ponds. Some studies have indicated that randomly placed on-site detention can actually increase peak flows and that a regional approach would be more effective.

Another concern with on -site detention is the long -term maintenance requirements. Since the detention pond will be placed on private property, it will be necessary to have a maintenance agreement or easement to ensure that the ponds are maintained. If they are not maintained, the basins will not be effective, and will likely turn into "eyesores." Because of the maintenance requirements and the potential problems, the public may not readily accept a pond being placed on their properties.

The use of on-site detention/retention is most appropriate for water-quality benefits. The use of grassed swales, filter strips, and infiltration basins can have a very beneficial effect on the quality of stormwater runoff. If on -site detention is required to control the volume of runoff, it is essential that the entire watershed be considered. A detailed hydrologic analysis must be prepared to determine the effect that the detention requirements will have on the flow characteristics of a watercourse.

REGIONAL FACILITIES

As noted earlier, in many instances, it is neither feasible nor advisable to require on-site detention. In such instances, a **regional** facility can be used to achieve the required detention.

A regional facility will usually require less land than would be required to achieve the same effects from numerous on -site facilities. There will also be a savings on construction and maintenance costs associated with a regional facility, as opposed to many on -site facilities.

As with on-site detention, the placement of a regional detention facility will require a hydrologic analysis of the watershed. Since a regional facility is normally placed on public land, the problem with easement and responsibility of maintenance will be minimized. However, there will still be the problem of providing adequate maintenance.

Regional facilities can be more readily accepted by the public if designed and maintained properly. Since regional facilities will be larger than on -site facilities, it is possible to incorporate multi-purpose uses into the design (such as soccer fields, football fields, fishing ponds, and parks).

Regional facilities are typically located in areas which provide natural storage. However, in most instances, wetlands are the "natural storage areas." Early in the planning process it is critical to consider the impacts that the detention facility will have on the wetland complex. The district office of the Land and Water Management Division should be consulted early in this process. See Appendix A for office locations.

OFF-LINE DETENTION (OFF STREAM)

Off-line detention is placed outside of the natural watercourse or storm sewer system (See Figure 6.2). The detention is achieved by diverting flows into a storage facility, when a certain flow rate is exceeded. Low flows will bypass the facility, thereby minimizing the warming of the water which may happen if the water passes through a detention facility.

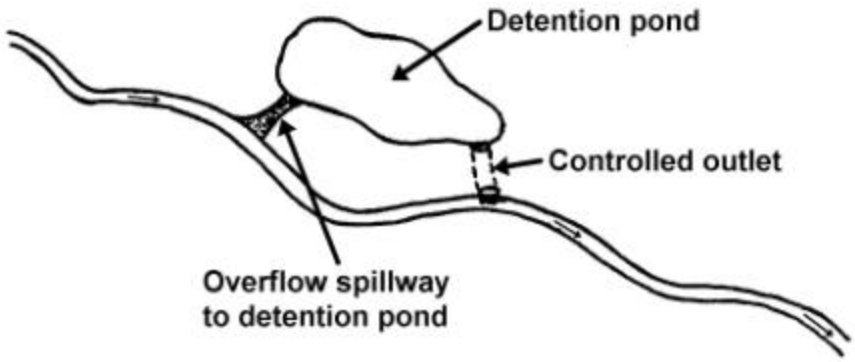

Figure 6.2 - Off-line Detention

Since the storage is not within the conveyance system, water may be stored as long as desired to achieve the necessary improvement in water quality or peak-flow reduction. However, care must be taken to ensure that the detention does not result in objectionable odors or health problems.

If not adequately designed, the inlet control devices may be overloaded, and the peak flow will not be attenuated as had been desired.

Off-line detention will require storage that may be considered to be "developable," and thus it may be difficult to obtain a detention site. Along the same line, if the area is already developed, a site may not be available that is off line.

IN-LINE (ON STREAM)

In-line detention is placed within the flow-carrying network (See Figure 6.3). If designed with adequate storage capacity, the in -line detention facility can provide attenuation to flood peaks. However, to achieve the required storage, it may be necessary to construct embankments and control structures, which will increase flood stages within the influence of the basin. If upstream property owners are affected by the increased flood stages, it will be necessary to obtain flooding easements. In some instances, it may be difficult and very expensive to obtain the flooding easements.

There is potential that water detained by an in -line detention basin may be warmed. If the basin discharges into a coldwater stream, it may be necessary to include a design that minimizes the warming, such as drawing water from near the bottom of the basin.

In-line detention can have a significant effect on the impoundment area upstream of the outlet structure. If wetlands are present, the impoundment may change the character of the wetlands. Also, the water quality within the basin may be degraded and important natural stream values lost. Thus, it is critical to work with the district office of the Land and Water Management Division to identify the wetland areas and if possible design a detention facility without significant degradation of natural resources.

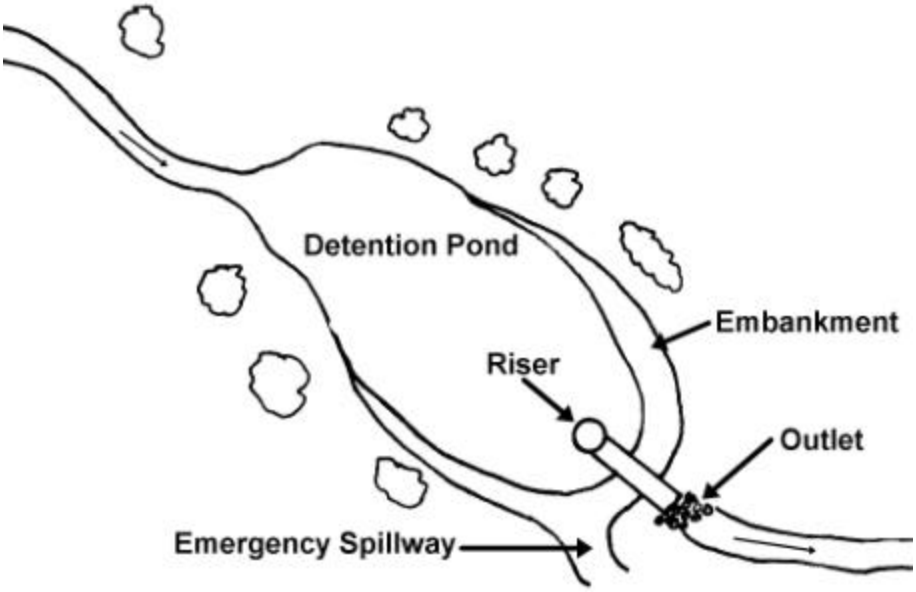

Figure 6.3 - In-line Detention